

A physicochemical approach to design bioactive scaffolds for tissue engineering

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Chapter 8

Valorisation

Scientific knowledge does not, by itself, result in widespread implementation and positive social impacts. The research from the laboratory must be translated in to practical use. This process, which is about creating impact through transfer scientific knowledge, is also called ‘valorisation of knowledge’ or ‘technology transfer’. Valorisation has been defined by Netherlands Proteomics Centre as “The process of value-creation out of knowledge, by making this knowledge suitable and available for economic or societal utilisation and to translate this into high-potential products, services, processes and industrial activity”[1]. The research in this dissertation is on fabrication of bioactive scaffolds for regenerative medicine. Some of the findings show high potential for valorization, especially, the one in chapter 5 where a novel technique is developed to fabricate nanofibrous scaffolds with tailored patterns. In the following sections, we will focus on elaborating the possible valorization options for chapter 5. First, I will start the discussion from a social and clinical relevance, and subsequently I will discuss about the novelty concept and potential application.

8.1. Social and clinical relevance

Tendon is a tough bundle of fibrous connective tissue that transfer forces between bone and muscle [2, 3]. Like low vascularized tissue of articular cartilages, tendons are characterized with low cell density, low oxygen and nutrient requirement, and poor healing capacity [2, 4]. The injury of tendon is common. For example, the yearly incidence for Achilles tendon is roughly 18 per 100,000 in the world and this number is thought to increase rapidly due to the growth of sports participation and ageing of the world population [5]. Given their poor self-regenerative capacity, surgical management is the only recourse for large tendon injury[4]. Unfortunately, current surgical reparative approaches which are often associated with auto- or allografts replacement, could not fully restore their functional and structural properties. Recently, tissue engineering has been established as a promising strategy for tendon regeneration. Scaffolds are considered as one of the most important principle elements of tissue engineering.

Currently, electrospinning has been extensively used to fabricate scaffolds for tendon repair due to its capacity to continuously generate nanofibers. However, the traditional electrospinning technique has difficulty in fabricating scaffolds with buckled patterns, which are of important topographical cues in the development of connective tissue, including tendon. Thus, we invented a new technique to overcome this issue.

8.2. Novelty of the concept

Chapter 5 describes a new method of making wavy fibers, comprising: (a) depositing electrospun fibers on a surface of a thermally shrinkable material, which material is shrinkable in at least one direction, wherein the deposited fiber at least partially adheres to the shrinkable material; (b) shrinking the shrinkable material in at least one direction, thereby buckling the fiber. The technique presented here is simple and low cost compared to prior arts [6, 7]. Firstly, the deposited fibers will attach to the thermal shrinkable materials automatically without extra bonding process. Secondly, extra fixating agents or methods are not required for retaining the wavy pattern. To the best of our knowledge, this is the first time we present a technique that is capable to generate buckled patterns on individual fibers, shifting to buckling the whole fibrous mesh through configuring fiber depositing time. Another notable advantage of the technique described in chapter 5 is that wavy patterns could be regulated in a wide range of options, such as verifying the orientation of depositing fibers, using a second layer of a water-soluble polymer to change the amplitude and frequency of the wavy patterns, and varying the geometry shape and kind of shrinkable materials. The pilot cell biology study demonstrated that the obtained wavy scaffolds promoted cellular penetration, which is one of the major concerns in terms of electrospun scaffolds for tissue engineering applications. In addition, pilot studies indicated that the obtained wavy scaffolds promoted TGF- β signaling expression that is a key signaling pathway involved in the development of several connective tissues including tendon.

8.3. Potential application

The results described in this dissertation may open doors to the development of fabricating functional scaffolds for tissue regeneration, especially where wavy topographical cues were needed. The successful translation of this technique described here toward society, firstly and most importantly, may benefit a great variety of patients who need to recover from tendon injury. The following approaches could be adopted to put this novel technique in the market. Firstly, it is worth filing a patent application for this

technique; secondly, a startup company could be formed to aim at producing scaffolds for tissue engineering. However, before producing the final products, further studies on growing more specific cells (such as tendon cell lines) on the obtained wavy scaffolds should be performed, followed by validation in a functional animal model. Thirdly, this technique could be sold to the market directly, for example, to those companies that are already active with electrospinning products.

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